TITLE

GENES ENCODING SULFATE ASSIMILATION PROTEINS

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This application is a divisional of U.S. Patent Application 09/720,524, filed December 21, 2000, U.S. Patent 6,720,172, which is a National Stage Application of PCT/US99/15812, filed July 13, 1999, which claims the benefit of U.S. Provisional Application No. 60/092,833, filed July 14, 1998.

FIELD OF THE INVENTION

This invention is in the field of plant molecular biology. More specifically, this invention pertains to nucleic acid fragments encoding sulfate assimilation proteins in plants and seeds.

BACKGROUND OF THE INVENTION

Sulfate assimilation is the process by which environmental sulfur is fixed into organic sulfur for use in cellular metabolism. The two major end products of this process are the essential amino acids cysteine and methionine. These amino acids are limiting in food and feed; they cannot be synthesized by animals and thus must be acquired from plant sources. Increasing the level of these amino acids in feed products is thus of major economic value. Key to that process is increasing the level of organic sulfur available for cysteine and methionine biosynthesis.

Multiple enzymes are involved in sulfur assimilation. These include: High affinity
sulfate transporter and [illegible] serve to transport
sulfur from the outsid[illegible] ie cell (Smith et al.
(1995) *PNAS 92(20)*:[illegible] denylyltransferase (ATP
sulfurylase) (Bolchia [illegible] atalyzes the first step in
assimilation, converti[illegible] denosine-5'
phosphosulfate (APS [illegible] ic sulfur for use in the

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biosynthesis of cysteine and methionine. For example, [illegible] ate kinase (APS kinase), catalyzes the conversion of APS to the biosynthetic intermediate PAPS (3'-phospho-adenosine - 5' phosphosulfate) (Arz et al. (1994) *Biochim. Biophy. Acta 1218(3)*:447-452). APS reductase (5' adenylyl phosphosulphate reductase) is utilized in an alternative pathway, resulting in an inorganic but cellularly bound (bound to a carrier), form of sulfur (sulfite) (Setya et al. (1996) *PNAS 93(23)*:13383-13388). Sulfite reductase further reduces the sulfite, still attached to the carrier, to sulfide and serine O-acetyltransferase converts serine to O-acetylserine, which will serve as the backbone to which the sulfide will be transferred to from the carrier to form cysteine (Yonelcura-Sakakibara et al. (1998) *J. Biolchem. 124(3)*:615-621 and Saito et al. (1995) *J. Biol. Chem. 270(27)*:16321-16326).

As described, each of these enzymes is involved in sulfate assimilation and the pathway leading to cysteine biosynthesis, which in turn serves as an organic sulfur donor for multiple other pathways in the cell, including methionine biosynthesis. Together or singly